1. Stronghold Family Overview
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5. Summary
1. Stronghold Family Overview
Challenges faced by operators worldwide:

- Plug & Abandonment (P&A).
- Slot recovery.
- Pressure in the annulus of a well.
Stronghold: Meeting Challenges

- The **Stronghold** family is a series of perforating, washing, cleaning and cementing systems that deliver safer, faster and more economic solutions for operators worldwide.

- By eliminating the need for cutting, milling, and underreaming, Archer’s Stronghold systems deliver a step-change in efficiency and effectiveness for placing a permanent barrier that can be verified.
Stronghold Family Overview

**Stronghold** – the Archer family name for solutions provided by:

- **Barricade**: Archer’s field proven Barricade system perforates, washes, and cements the annulus, creating a rock-to-rock barrier in just one trip.

- **Defender**: Archer's field proven barrier test system enables operators to perforate and test annular barrier.

- **Rampart**: Archer’s new ground-breaking cup-less system perforates, cleans, and cements the annulus, creating a rock-to-rock barrier in just one trip.

![The Barricade](image)
### Stronghold Family: One-trip Systems

<table>
<thead>
<tr>
<th>Barricade</th>
<th>Defender</th>
<th>Rampart</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Perforates tubulars.</td>
<td>- Barrier testing</td>
<td>- Perforates tubulars.</td>
</tr>
<tr>
<td>- Washes and cleans the annulus of perforated tubular in a selected zone and places a permanent, rock-to-rock barrier.</td>
<td>- Perforates tubulars.</td>
<td>- Cleans out annular debris, vortex effect.</td>
</tr>
<tr>
<td>- Places cement.</td>
<td>- Confirms and verifies an annular barrier.</td>
<td>- Cleans the annulus of perforated tubular in a selected zone and places a permanent, rock-to-rock barrier.</td>
</tr>
<tr>
<td></td>
<td>- Places cement.</td>
<td>- Places cement.</td>
</tr>
</tbody>
</table>

### Result

One trip systems, absolute protection – Stronghold.
Stronghold

Stronghold: the modern perforation, wash, clean and cement technique for a permanent barrier. Safe, quick and cost-effective.

Stronghold – by Archer.
2. Stronghold Barricade
A permanent “rock-to-rock” barrier achieved in a single trip.

Archer’s field proven Barricade is designed to wash the annulus of a perforated interval through a tubular(s) by:
- Perforating the casing or liner.
- Washing outside the perforated interval.
- Placing spacer fluid in the casing and outside the perforated interval.
- Placing barrier material in the casing and outside the perforated interval.

Result: one trip, absolute protection – Stronghold.
Evolution of Barricade

- **1st Generation Perforate and Wash Method**
  - First job performed for ConocoPhillips (Eldfisk A) in 2010. A three-trip system.

- **2nd Generation Perforate and Wash Method**
  - Performed for ConocoPhillips (Ekofisk M) in 2014. Used the dual swab cups to place the cement accurately. Evolved from a two-trip system into a one-trip system, including perforations.

- **New Heavy Duty Swab Cups**
  - Introduced in January 2015 to increase reliability and robustness of the Stronghold family of tools.

- **High Performance Swivel**
  - Introduced in February 2015 to enable the string to be rotated with 120 rpm for improved hole cleaning.
Barricade System

Swivel

Perf Wash Tool

Ball Seat Assy

By-pass system

Primary and B/U Swab Cups

Auto Gun Release

Perforation Guns
Benefits

- Single run system with perforation guns on the same run.
- Controlled washing with standpipe pressure as performance indicator.
- Excellent hole cleaning capabilities with high rotation (120 rpm).
- Accurate placement of cement using the dual swab cups.
- No need to squeeze or wait on cement (WOC). Time saving – approximately 16-24 hours.
- Time efficient: 165 ft / 50 meter average 12 hours.
- Deepest performed Barricade job; 3500 mMD / 11480 ft.
- Max deviation to date; 67 deg.
  - Single trip, washed and cemented with success.
- Longest washed interval to date; 77 m / 250 ft (most common 50 m / 165 ft).
- Barricade jobs performed:
  - 1 ea 7”.
  - 45 ea 9 5/8”.
  - 6 ea 10 ¾”.
  - 1 ea 11 ¾”.
  - 8 ea 13 3/8”.
12 zones perforated and/or washed from January 2010 to June 2014:

- 4 Statoil (Norway)
- 3 Conoco Phillips (Norway)
- 3 BP (Norway)
- 1 Shell (UK)
- 1 Perenco (UK)
64 zones perforated and/or washed from July 2014 to August 2016 for:

- Conoco Phillips (Norway)
- BP (Norway)
- Mærsk (UK and Denmark)
- Statoil (Norway)
- Canadian Natural Resources Ltd (UK)
- ExxonMobil (Malaysia)
Case study: Slot recovery in the North Sea

Stronghold Barricade reduces time and provides increased efficiency on slot recovery

Challenge
A North Sea customer challenged Archer to plug and abandon a well to legislative requirements while increasing the efficiency of the process. Additionally, the challenge involved recovering the slot back to above the top of the 10” liner hanger to facilitate a new sidetrack.

Traditional plug and abandonment methods are often time consuming and costly. The compound complexity of milling,

Region: North Sea
Customer: Major Operator
Field: Norwegian Continental Shelf
Well type: Oil and gas

Case benefits
- The Barricade eliminated the need to mill casing
- Provided a clean and open annular space in which to place cement
- The Archer Barricade method ensured that the cement enters the perforations with the dual swab cups that direct the flow of
Success Story: Reducing Costs on Statfjord

Case study: Stronghold Barricade

Reducing cost and improving effectiveness of P&A on Statfjord.

Challenge
Statoil was seeking an efficient and reliable method to plug and abandon its well (P&A), whilst minimizing the use of rig time, and ensuring an effective, long-lasting seal.

Traditional P&A methods are often time consuming and costly—the need for milling and debris handling, perforating, and then preparation of the seal zone to receive cement, the deployment of a rock-for-rock cement seal; and the subsequent verification of the seal using logging techniques, can all add complexity and risk. Also, squeezing cement into perforations without washing and purging the perforated zone can reduce the chance of success.

Region: North Sea
Customer: Statoil
Field: Statfjord
Well type: Oil and gas

Case benefits
- The Barricade eliminated the need to mill casing and provide more security when drilling out cement.
- Provided a clean and open annular space in which to place cement.
- Customer was able to set a balanced cement plug and squeezed cement into washed perforations.

Key capabilities
- Field proven
- High circulation rates
- Adjustable distance between swab cups
- Dual swab cup design
- Flow bypass system
Basic Operational Sequence

1. Wash down and up
2. Displace annulus to Spacer fluid
3. Displace annulus to barrier material
4. Barrier in place
Log Before and After Operation
## Log after Perforate and Wash Operation

<table>
<thead>
<tr>
<th>Interval Top (mMD)</th>
<th>Interval Length (mMD)</th>
<th>Cement or Formation or Combination of both</th>
<th>Cement or Formation Bond Quality</th>
<th>Formation log response checked against reference log response (tested formation)</th>
<th>Potential for Hydraulic Isolation ¹</th>
<th>Length of Interval if Isolating Potential is ‘High’ (m)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Perforated interval</td>
<td>3</td>
<td>Cement</td>
<td>Good</td>
<td>No</td>
<td>High</td>
<td>3</td>
<td>The data indicates well bonded cement with high impedance in the whole annulus around the casing.</td>
</tr>
<tr>
<td>+3</td>
<td>3</td>
<td>Cement</td>
<td>Good/moderate</td>
<td>No</td>
<td>High to medium</td>
<td></td>
<td>The data indicates a lot of cement in the annulus and this interval might also be isolating, but here is slightly lower impedance and less dampening in the VDL than in the intervals above and below.</td>
</tr>
<tr>
<td>+6</td>
<td>20</td>
<td>Cement</td>
<td>Good</td>
<td>No</td>
<td>High</td>
<td>20</td>
<td>The data indicates well bonded cement with high impedance in the whole annulus around the casing.</td>
</tr>
<tr>
<td>+28</td>
<td>5</td>
<td>Cement</td>
<td>Good</td>
<td>No</td>
<td>High</td>
<td>5</td>
<td>The data indicates well bonded cement with high impedance in the whole annulus around the casing. Based on USIT data alone.</td>
</tr>
<tr>
<td>+31</td>
<td>3</td>
<td>Formation</td>
<td>Poor</td>
<td>No</td>
<td>Low</td>
<td></td>
<td>Fluid/low impedance material. Based on USIT data alone.</td>
</tr>
</tbody>
</table>
2. Defender – Barrier Test System
Defender Introduction

- The Defender system provides a safe, quick, economical and effective alternative to traditional P&A techniques of casing recovery, milling and Perforate, Wash and Cement.

- Traditionally, several runs were required to test the annulus. Setting two plugs and perforating usually took up to 3 runs.

- Archer's Defender system achieves this in just 1 trip by:
  - Perforating the casing or liner.
  - Verifying the integrity of the annulus.
  - Placing barrier material in the casing and annulus.

Result: permanent verified barrier achieved in a single trip; a simple, cost effective solution for annular remediation – Stronghold.
Defender Barrier Test System

Using Tubing Conveyed Perforation (TCP) and the Defender, the annular or formation/shale squeeze integrity can be tested. The swab cups are spaced further apart than for the Barricade.

Shoot the loaded sections at the top and bottom of the zone of interest. Multiple zones can be shot in 1 trip.
Defender Operational Sequence

RIH & Perf

Pressure Test Across Perfs

Cement
Benefits

- Single run system with perforation guns on the same run.
- Perforates, verifies and cements all in one run.
- Time efficient average of 12 hours from run in hole to cement is pumped.
- No need to squeeze or wait on cement (WOC). Time saving – approximately 16-24 hours.
15 zones perforated and tested from 2013 to 2016:

- Statoil (Norway)
- Conoco Phillips (Norway)
- BP (Norway)
Case study: Stronghold Defender

Pressure test formation behind 13 3/8” casing through perforated 9 5/8” casing and cement.

Challenge
The main challenge was to locate the 6 ea perforated intervals of only 1 feet between 2078.2 m to 2160 m and pressure test them to 40 Bar.

Region: North Sea
Customer: Statoil
Field: Stafford
Well type: A-36A
Reference: Thaniop Hongdul and Jørgen Bugge-Mahn

Key capabilities
- Effective rock-to-rock cement barrier
- Significant time and cost savings
- Efficient one-trip system
- Eliminates need for section milling and swarf handling
- No surge or swab effect

Typical applications
- Permanent abandonment
- Screen washing
3. Rampart – Vortex Based Annular Cleaning & Cementing System
Rampart Introduction

- The Archer Rampart system provides a safe, quick, economical and effective alternative to traditional P&A techniques of casing recovery and milling.
- It can be applied when limited access to the wellbore prevents access for traditional equipment. Archer's one-trip Rampart system achieves this by:
  - Perforating the casing or liner.
  - Cleaning the annulus with a high velocity vortex effect.
  - Placing the barrier material in the casing and annulus.

Result: a permanent “rock-to-rock” barrier achieved in a single trip – Stronghold.
The Rampart is a new groundbreaking vortex annular cleaning and cementing system in the perforate clean and cement market.

The Rampart cleans the annulus and transports debris efficiently out of the well due to the induced vortex effect.

The Rampart technology does not apply high force to the annulus and reduces the risk of losses during the cleaning and cementing process.
Rampart System

Handling Joint

Auto Gun Release

Rampart Tool

Perforation Guns
4. Summary
Summary

The Stronghold family comprises one-trip modern perforation, wash, clean and cement systems:

- Barricade.
- Defender.
- Rampart.

Together with Tubing Conveyed Perforating (TCP) products and new charge development, Archer’s Stronghold systems support the safe and efficient execution of operations.

The Result:
A verifiable rock-to-rock barrier.
Thank you